THE FIRST MANNED MARS STATION

Armstrong Station, *Chryse Planitia*, Mars

America's first manned scientific outpost assembled on the surface of Mars will need to be flown unmanned to the designated location and consolidated over a period of 4 to 6 years, sending several sections at a time launched from Earth during opportunities of favorable Mars/Earth orbital position which occur approximately every 26 months. The first section to land would necessarily be the Central Control Station to which all four primary follow-up modules would connect at air locks. The follow-up modules would be required to land very close to the Central Control Station, guided in by an array of powerful electronic signals broadcast by the Central Control Station and would be driven semi-automatically to the Central Control Station for linkup remotely. It will be critical for these modules to land as close as possible to the Central Control Station if the first manned Mars exploration operation is to be successful. A landing even a few miles too far away is simply unacceptable.

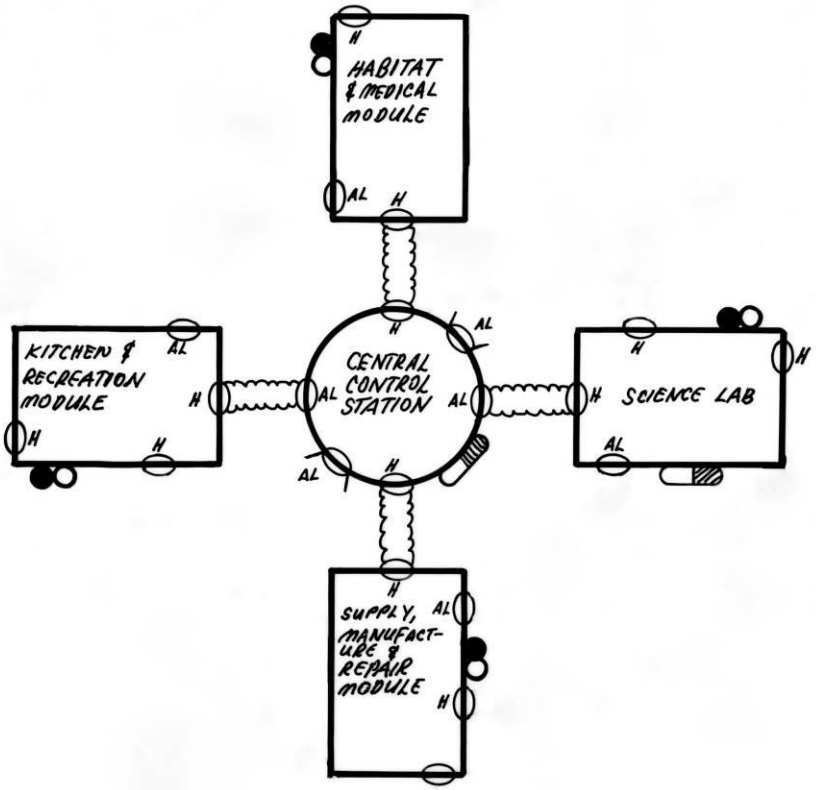
These first primary modules would include a Habitat and Medical Module, a Kitchen and Recreation Module, a Science Lab, and a Manufacturing and Repair Module.

Automatic pre-manned configuration and operation

(Unmanned)

Once in place these modules will automatically begin the extraction of valuable gases from the Martian atmosphere including oxygen and water molecules. Before the first crew arrives these extraction units will be programmed to completely fill their storage tanks as automatic on site back-up supplies of these critical resources, and even though the process is time consuming using a goodly amount of energy to accomplish, there is no required time frame or deadline for the completion of the task. Redundancy is the key to successful surface operations.

AL = Air Lock, H = Hatch



Each pre-positioned module will be programmed to charge onboard electrical storage batteries using roof deployed solar panels as the primary electrical system to support operations before and as a back-up system after crew occupation. A secondary energy supply will come from each of the small nuclear powered generators attached to the outside of each module. Hydrogen electrical power generators, also part of each module will not be used until the station is manned, but can be put online remotely if required at any time.

After the pre-manned configuration assembly is complete and fully tested additional supplies will be landed nearby which will include supplies of food, water, liquid oxygen, hydrogen fuel, stored inflatable green houses with seeds and supporting fertilizers, extended roll out surface solar panels, additional nuclear power rods, spare parts and any critical equipment required to sustain a surface crew of four astronauts for a period of at least two years.

To be successful the station must be initially set up, fully equipped and supplied to operate independently and manned without the need to bring any further supplies from Earth or the need to create any additional critical supplies during that first time period on the surface. Growing additional food sources and capturing additional atmospheric gases and water during this first mission must be viewed as secondary back-ups and test units only, and not counted on to primarily support the mission.

The first humans to land on Mars to make more "giant leaps for mankind" will then be able to enter the facility and begin the process of expanding the station to its full occupation configuration.

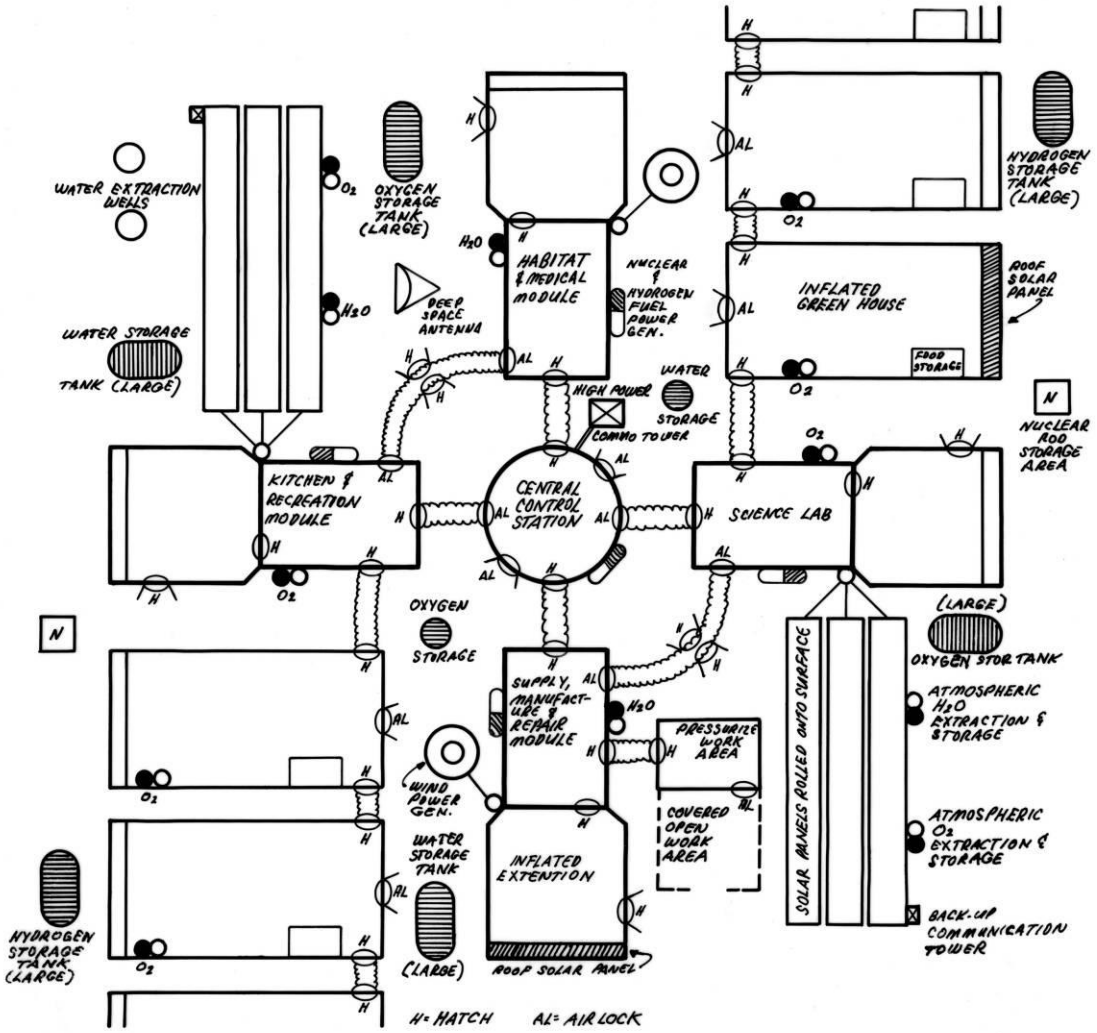
Armstrong Station Manned configuration

(4 crew members)

Armstrong Station (named after astronaut Neil Armstrong) will be initially manned by four astronaut/scientists representing the first team to set foot on Mars. Although science and discovery is one of the many goals of manned exploration of Mars, a good percentage of effort by the first Martian landing team will naturally focus on setting up the station for future operations. It will take months to expand and erect all of the greenhouses, set up the scientific equipment, drill the water extraction wells, deploy extended solar cells and assemble the wind power generators. It should also be kept in mind that this first operational station is completely experimental and constitutes the small first step towards a permanently manned Earth colony on Mars and beyond.

As written above, each module should be equipped with a small outside attached nuclear power generator (an RTG or Radioisotope Thermoelectric Generator), a small outside attached hydrogen power generator, an oxygen or water atmospheric extraction unit and storage tank, a roof solar panel, an inflatable extension area designed to double the modules' working area; 2 primary and at least 1 secondary hatch and air lock, small supplies of food, water, oxygen and medical supplies and at least 1 spare general use pressure suit, as well as a power storage battery. Each module will also house a small Earth link radio initially used to direct the modules during assembly, but at this stage turned off and only used as a backup system capable of emergency module-to-module communication. Additionally two of the modules would be equipped with roof escape hatches for emergency evacuation.

The Central Control Module would be the only two-story module during the early stage of deployment which includes powerful direct radio/telemetry links by several systems to Earth as well as a capability to receive direct telemetry from Mars orbiting satellites and any future manned or unmanned surface vehicles. Needless to say, Mars Station Mission Control on Earth will be manned 24/7 to monitor all surface station operations and will be prepared to transmit any technical support requested by the surface team at all times. To support crew safety the Central Control Module would be hardened against radiation and solar storms. A later delivery of a stand-up 360^{o} Martian view copula would be placed over a roof escape hatch of the module to allow the crew a panoramic view of the surrounding area.



The Habitat and medical module would also be hardened against radiation and solar storms. It would contain four small sleeping quarters, a small bathroom and a fully stocked dental, examination and operating room.

The Kitchen and Recreation Module will house the galley, a food storage and refrigeration unit, central table and four chairs, a long couch, exercise equipment and the electronic library with additional personal computers for each of the crew members.

Armstrong Station power would be provided by several small nuclear power generators (RTG), several small hydrogen power generators, two electrical generating windmills, two large primary rolled out solar panels on the surface as well as small solar panels on the roofs of each module as well as a small roof solar panel section on each green house. As the number of greenhouses increase added solar panels will also increase in number. Once again redundancy and back-ups are critical.

Oxygen is extracted from the Martian atmosphere by units attached to the Kitchen and Recreation Module and the Science Lab; additional units are attached directly to the large solar panels, with extraction units deployed inside each green house. Extended oxygen supplies are stored in two large and one small tank on the surface. Original oxygen supplies will be landed with or prior to the first team of astronauts arrival. Each module would be equipped with an emergency oxygen tank.

Water (H_2O) is extracted from the Martian atmosphere by units attached to the Habitat and Medical Module and the Supply, Manufacturing and Repair Module, extraction units attached to the large

solar panels and Water Extraction Wells. Water (H_2O) supplies are stored in two large and one small tank on the surface. Original water (H_2O) supplies will be landed with or prior to the first team of astronauts arrival. Each module is equipped with a small emergency water tank. A water cracking unit would be attached to the Supply, Manufacturing and Repair Module to separate oxygen and hydrogen from water. This unit must be considered a secondary device and not counted upon as a primary supplier of oxygen.

Each inflated Green House unit contains an oxygen extraction unit (internal/external) and storage tank, roof solar panels, refrigeration unit and food storage locker as well as two hatches and one air lock.

A secondary deep space antenna will be located near either the Central Control Center or the Science Lab and linked in directly by ground cable to each with a back-up short range radio link. The Science Lab will also operate as a back-up communication center in the event the Central Control Station becomes in-operational using its direct cable links to the primary communications tower and the Deep Space Antenna.

Situated near and connected to the Central Control Station is a powerful communication tower with smaller back-up communication towers connected to each of the two primary rolled out solar panels.

There will also be two separate nuclear rod storage areas situated well away from the crew living and working areas, as well as two hydrogen storage tanks.

The Mars surface team would be working on 'Martian time.' The Martian day or Sol is equal to 24 hours, 39 minutes and 36 seconds 'Earth time'. Each hour would then be equal to 61.65 'Earth minutes'. Considering how close the hours match it would not be a problem to design special Martian clocks that mark a Martian day with slightly longer 24 Martian hours, (1 minute 39 seconds Earth time) which would likely not be noticed by the crew. Earth based controllers would be required to adapt to 'Martian time.'

Taken as a whole, the surface team would be able to operate in a shirt sleeve environment throughout the entire station. Outside extra station activity (ESA) would be conducted in full pressure suits with access to the Martian environment available through several air locks stationed throughout the station although it is expected that a primary and secondary air lock will be designated as standard use exits, most likely in the Central Control Center, leaving other airlocks unused until needed if the primary and secondary air locks become inoperative or problematic.

The final support facility will be a small, but fully equipped Mars Orbital Station - Collins Station (named after astronaut Michael Collins).

Expanded Armstrong Station

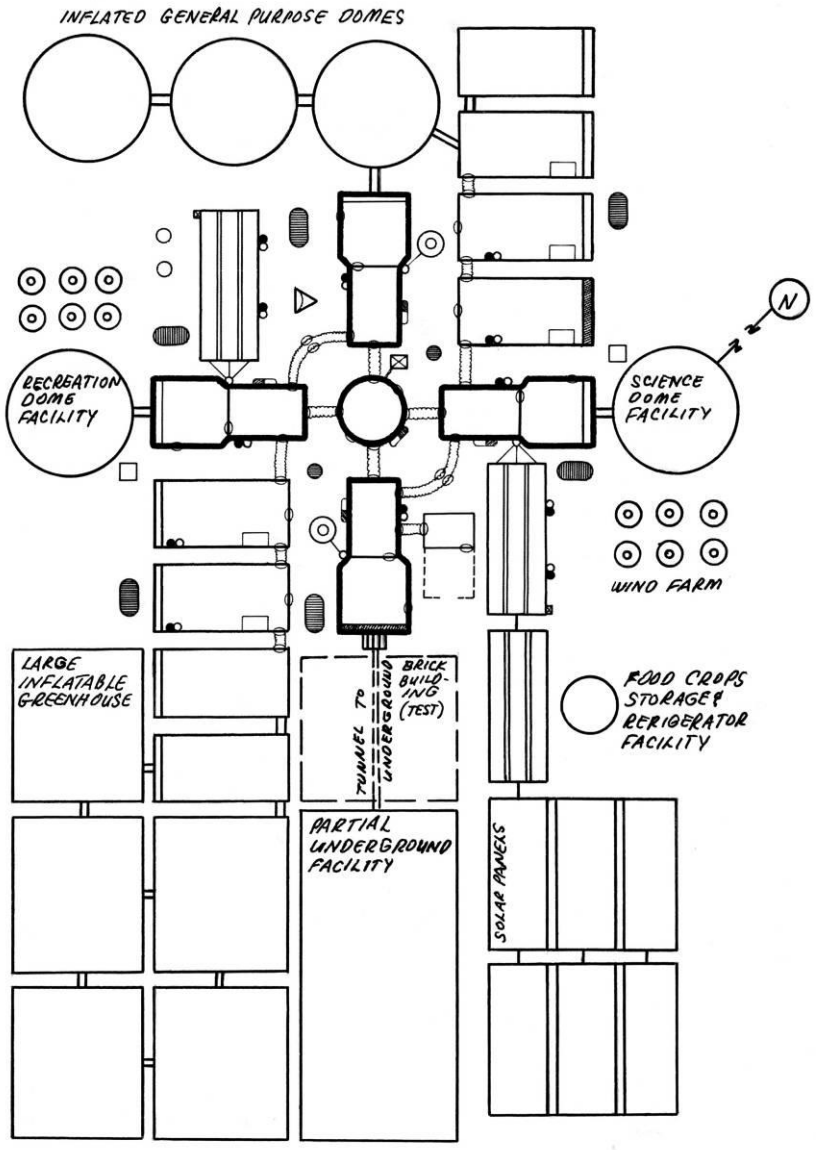
(6 to 10 crew members)

The first new station support equipment to land on Mars before the station can support a crew of six to ten would be the unmanned automatic landing of a return-to-Mars-orbit vehicle capable of carrying the entire surface team to Mars orbit should a complete evacuation of Armstrong Station be required. The evacuation craft would then dock with the unmanned but occupation ready Collins Station in orbit around Mars. Within 4 years Collins Station would be expanded and manned by a small orbital team of 3 to 4 astronauts. The station would have an additional docked return-to-Mars-orbit vehicle as well as a vehicle designed to return Martian astronauts back to Earth.

Following the landing of the evacuation vehicle the first objective of a follow-up and expanded Mars surface team will be to expand the Armstrong Station working areas accessible to the crew in a shirt sleeve environment. Along with this development of working space expansion the crew will necessarily expand energy, atmospheric gases extraction and food producing capabilities, as well as upgrading any equipment or areas of the station needing repair or replacement.

As this work is completed it will allow for a larger surface staff to develop new areas that had not as yet been possible. First will be the construction of a large auditorium size structure built partially underground (approx half sunk into the ground). This large inflated facility will need to be assembled

from several sections, connected to form one large open space which can be used for many purposes. However, the primary reason for assembling such a large open facility (relative to the cramped original modules) will be psychological, as it will give the crew an operational open shirt sleeve area which will be unlike the close in 'tin-can' environment found in the rest of the station. Connected to the station by a dug-out underground pressurized hallway the new structure would best be devoted to the comfort and mental well being of the surface staff, especially those personnel expected to remain at the station for extended periods of time (4 to 6 years).



Divided into two large areas the far end of the structure farthest away from the very active central station area could be worked into an area of up to six new individual sleeping quarters, a small kitchen and storage area, two restrooms a projection room and an open lounge, game table and dining area complete with library. The other half should be left as wide open as possible with as few visible obstructions as possible. To support any possible emergency situations the auditorium should be equipped with a complete, but limited set of supplies including oxygen, water, food, medical supplies, at least three general purpose pressure suits, a rooftop solar panel and small nuclear power generator. Entrance into the auditorium will normally be through the pressurized hallway, however at least two airlocks should be positioned at opposite ends of the facility for maximum safety considerations should evacuation be

required if the hallway or facility fails for any reason. The facility should also have an airlock connecting it to one of the greenhouses for internal evacuation.

The second new expansion would include setting up several inflated geodesic dome structures which can be connected to any of the original primary modules, any one of the greenhouses or in a series to each other. Each of these new domes will support the station with individual solar panels and storage capabilities. The station would now have available a shirt sleeve environment some three times larger than the original shirt sleeve environment available using the modules alone.

The Recreation Dome could be supplied with a small above ground pool, small spa, exercise equipment and a music listening room. A portion of the dome would be developed into a garden area growing a number of different consumable and non-consumable plants including small trees. Once again the psychological health of the surface team is the primary reason for the construction of this dome.

The new Science Dome facility will include the capability to deploy a balloon up to several thousand feet on a tether with a bright flashing light and radio beacon as a back-up guide post for surface exploration teams to be able to locate Armstrong base visually or by tracking signal if necessary.

Larger inflatable greenhouses would be constructed and linked to the smaller greenhouses already deployed at the base. These new greenhouses could become capable of supporting small fruit trees including apples and oranges, etc. Solar greenhouse effect will serve to keep these and earlier deployed greenhouse structures at a comfortable (above freezing) temperature; supplemented by in-situ heat/coolers.

This new team will also be expected to build the first above ground station facility using insitu resources found on the planet without any additional supplies from Earth. Essentially this will be a structure built of bricks and mortar made from Martian materials as a test structure. When completed the new structure will be pressurized and linked to the rest of the station via a brick constructed above ground pressurized walkway as well as a secondary tunnel similar, but much longer to the ones used to connect the first original primary modules.

New power generating systems will be deployed including extended ground rolled out solar panels set and linked to panels already deployed along with a larger assembled off-site nuclear power station capable of supporting all station power requirements on its own. This new power station will render all earlier nuclear power generators as secondary back-up systems, adding a new redundancy for the station. Additional windmills will be set up in at least two wind farm designated areas to increase redundancy in that area as well.

A large automatic water (H_2O) atmospheric extraction unit with large storage tanks will be assembled near the station capable of extracting sufficient water from the Martian atmosphere to supply all the water needs of the station on its own thus regulating other much smaller extraction units and wells to back-up status. The smaller units will then be held in stand-by mode and maintained in case of emergency, thus ensuring a new emergency capability and longer lifetimes for these smaller older units.

The extended station would also include a small inflated grain storage facility, including a refrigeration capability to maintain a constant storage temperature. Several can be deployed to insure a growing capability to store several types of food stuffs above general requirements for years. Stored foods would be rotated to ensure the freshness of the materials.

It is expected by this time that the station will be supported by two types of manned rovers both open and pressurized as well as several types of unmanned rovers remotely controlled by station team members and small drone-like helicopters for scientific research. The rovers would be powered by combustible engines using methane and oxygen whose waste product would be liquid or gaseous water which can be captured by onboard condensers. Back-up power would be supplied by a battery, which itself can be recharged by a stored collapsible emergency solar array if needed.

The station will also be linked to a series of small orbiting communication satellites capable of GPS functions to allow greater understanding of locations related to extended manned surface

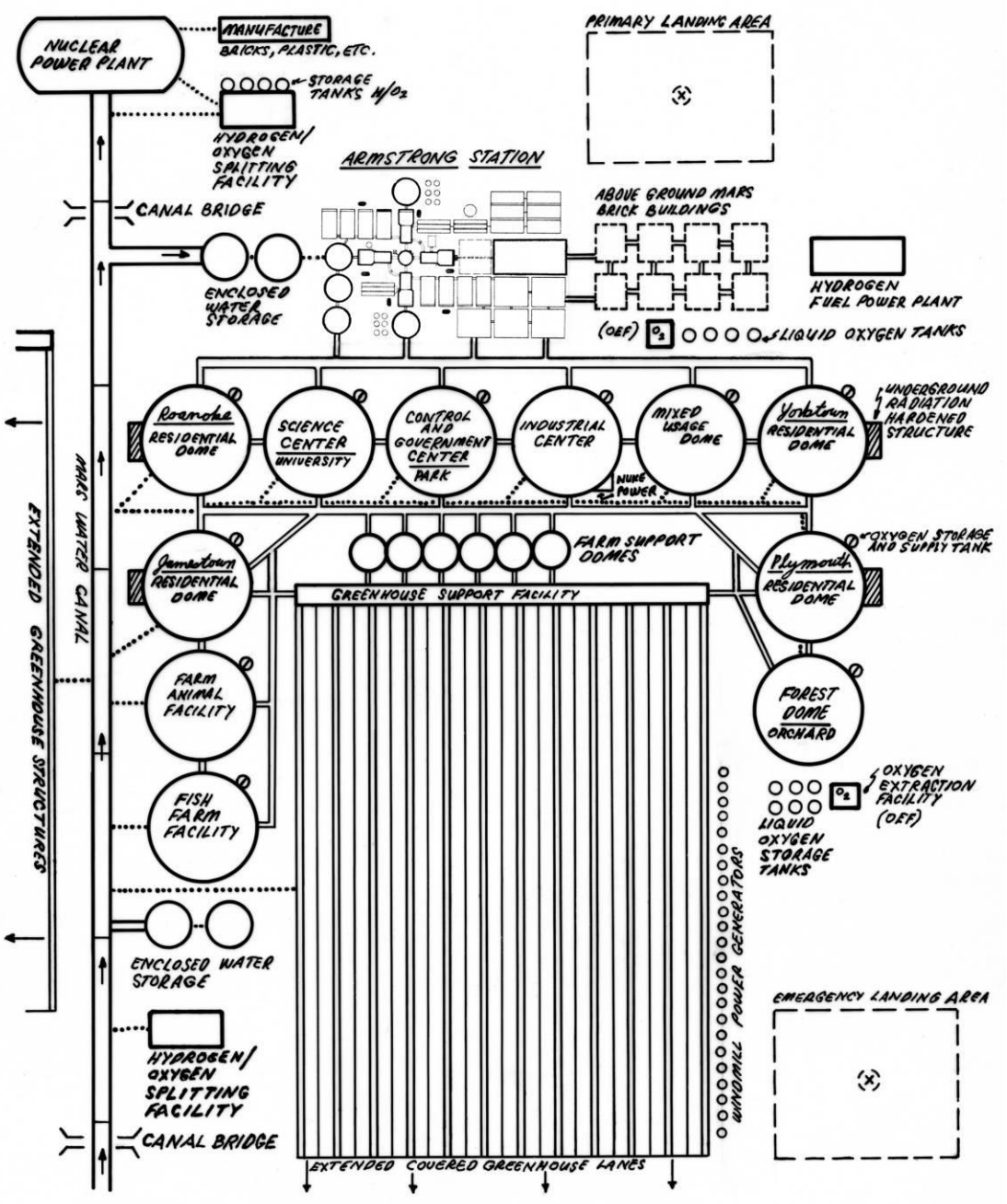
explorations, or a geostationary satellite positioned in orbit over Armstrong Station. The station could also be linked by radio to the small Mars orbiting station manned by a small crew of astronauts.

By this point in the development of Martian surface capabilities several small off-station automatic and man serviced exploration outposts will have been established with the capability of hosting a small team of astronauts for a limited amount of time; with man capable outposts capable of supporting a two man team for up to 30 days or more.

At this time the now expanded station should be capable of supporting a surface crew of twenty for an indefinite period of time. These numbers will slowly be increased as the capabilities to support such numbers increases until they are large enough to begin the actual colonizing of Planet Mars. This would constitute the beginning of a permanent occupation of Mars by humans from Earth and those born on the planet.

New Terra Colony
(300 colonists)

The definition of a Martian colony must certainly be when a group of individuals fly from Earth to arrive on Mars with no expectation of ever returning to Earth. Mars will be their new home where they will live out the rest of their lives. They and their offspring will have become the first true Martians. This would only be possible when the Mars surface facility is completely self sufficient requiring no further assistance from Earth in order to safely operate indefinitely and continue to expand.



The first large dome structures will be assembled from materials found on Mars, supplemented by resources supplied from Earth. Later large domes will be constructed using only materials found on Mars and manufactured in facilities within the growing colony. Areas within the large domes can be subdivided

by panels and walls built by bricks and plastics manufactured on Mars using local materials. Additional support for these large structures would come from thick brick walls built against and bolted to the lower portion of the structure wall on the inside and outside with added soil pushed up against the outside brick wall for greater stability.

Large dome usage would be divided into 4 residential areas; *Jamestown*, *Roanoke*, *Yorktown* and *Plymouth* with small "green areas"; a Science and University Center, which includes a full medical facility; a Farm Animal Facility; a Fish Farm Facility; an Industrial Center; a Forest and Orchard Dome; a Control and Governmental Center with a large park area including the first small privately owned part-time shops, a medium sized 'outdoor' in ground swimming pool, as well as a recreation and sports area, and finally a mixed usage dome to be used as needed.

New Terra Colony food requirements would be supported by greenhouses already in operation as well as new pressurized extended long-tube sectional greenhouses. Each extension tube will be tall enough for a crew member to walk upright and be supported by a long row of solar panels. Further food supplies will come from the large dome Fish Farm Facility, the Farm Animal Facility, Farm Support Domes and the orchard section in the Forest Dome. Additionally, vegetables such as tomatoes, etc. grown in each of the four Residential Domes in areas set aside for planting a variety of crops will add to the selection of food stuffs. In addition the three Inflated General Purpose Domes and Recreation Dome at Armstrong Station, no longer needed for their original purposes, can be converted into food production facilities simply by bringing in a layer of Martian top soil and planting crops or fruit bearing trees.

To supply the colony with enough water to support all activities the first true manmade Martian canal will need to be constructed with a trench-like structure on the surface. Powered by solar panels and back-up nuclear energy the canal with a Martian material supplied concrete floor and plexiglas cover will transport water from wells dug below the Martian surface tapping into underground aquifers. The canal cover will be made into sections that can be replaced or repaired as required and the canal itself can be sectioned to hold back the flow of water if the need arises to repair the floor of the canal while allowing the rest of the system to remain pressurized during repairs. Above freezing temperatures will be maintained by solar radiation (greenhouse effect) and supplemented if need be by small heating units placed along the length of the canal. Additional water supplies will be extracted from the Martian soil by surface vehicles using a movable greenhouse type structure positioned on the surface allowing the solar radiation to heat the soil releasing any water from the permafrost known to be very close to the surface of Mars in many extended locations. Used at this point only as backups, the original extraction units will continue to operate until no longer functional.

A new off-site nuclear fusion power plant will be constructed using deuterium initially supplied from Earth but readily extracted from the soils of Mars rendering the facility completely self-sufficient from any further supplies from Earth once it has been placed into operation using the original supply of material supplied from Earth.

Oxygen supplies will be extracted from the atmosphere using two new large oxygen extraction facilities as well as the existing smaller units. Additionally, water will be used in two new Hydrogen/oxygen Splitting Facilities to separate out oxygen and hydrogen both to be stored in large storage tanks at several locations within the colony as well as pumped into all areas of the colony. Oxygen will also be removed from the extended greenhouses as needed.

Off Site

It would be necessary to construct a large emergency supply depot at least thousands of feet away from the colony, probably further away, in which oxygen, water and other critical life sustaining supplies are generated and stored. The depot could be sustained with power supplied by both solar cells and a small nuclear power generator. The depot would also hold stored food grains, freeze dried fish, meats and other proteins as well as colony grown fruits and vegetables. It would also store replacement parts and

vehicles to be used as needed. A small crew housing facility would be constructed on site manned by rotating crew members from the colony. It could be as small as the original Armstrong Station. After a while the small off site station could be expanded as requirements dictate to become the second colony on Mars.

"It is essential that we colonize space."
Dr. Stephen Hawking